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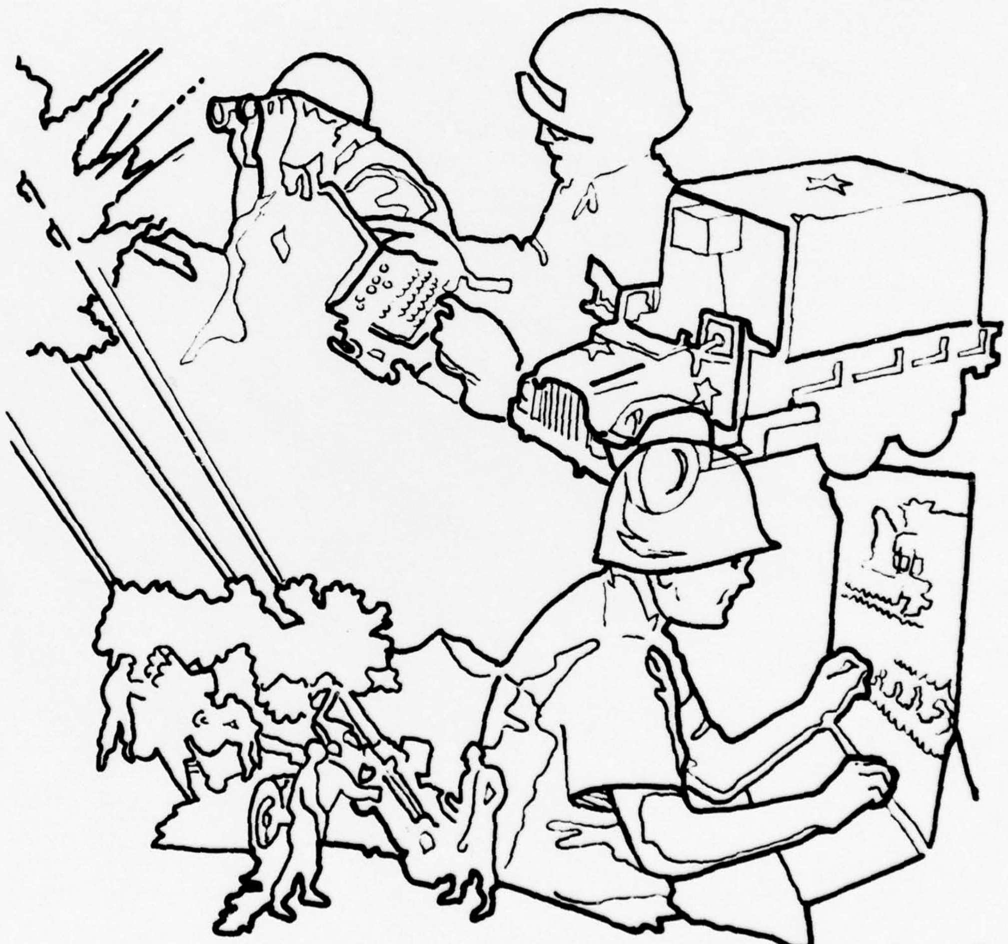
COMPUTERIZED COLLECTIVE TRAINING FOR TEAMS



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A review and evaluation was conducted of state-of-the-art findings and instructional theory directly applicable to the problem of developing instructional strategies for computer-assisted team training. Two major conclusions were drawn from the review and evaluation. The first is that a conceptual framework for a general purpose set of instruction strategies for team training does not exist. The second conclusion is that an Instructional Systems Development (ISD) approach must be developed for team training.

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20. The paper also describes the initial development for deriving team training instructional strategies. Three major elements were identified and integrated into a framework which will be refined in subsequent efforts. These elements are: (1) team task dimensions and team training objectives, (2) learner characteristics and strategies, (3) characteristics of the training delivery system used to implement the strategies. The dimensions of the elements selected are preliminary and will be refined and firmly delineated by subsequent research.

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FOREWORD

The Educational Technology and Training Simulation Technical Area of the Army Research Institute for the Behavioral and Social Sciences (ARI) conducts research to support the development of training concepts and evaluation techniques for applying automation, simulation and training devices in a unit setting. A training concept currently under study is the use of automation, viz., tactical computers, for training. Tactical computers have great potential for presenting individual and collective (or team) training. Individual training using the tactical computer has been developed and evaluated. The development of team training was an expressed priority of the recent Defense Science Board Report to the Director of Defense Research and Engineering. In anticipation of the Defense Science Board Report, the present Technical Report reviews the problems of the development of instructional strategies for conducting team training and examines the potential of the computer for controlling and monitoring team training.

The research reported herein was jointly sponsored by ARI and the Defense Advanced Research Projects Agency (ARPA Order 2887), and is responsive to specific requirements of the U.S. Army Field Artillery School, the Training Support Center of the U.S. Army Training and Doctrine Command, and to Army Project 2Q762722A764. The work reported on here was performed by Sensors, Data, Decisions, Inc. under the technical monitorship of James D. Baker, Chief of the Educational Technology and Training Simulation Technical Area, ARI.

J. E. UHLANER
Technical Director

COMPUTERIZED COLLECTIVE TRAINING FOR TEAMS

BRIEF

Requirement:

To present the results of a state-of-the-art assessment of instructional strategies for computerized collective training for teams ($COLT^2$). The objective was to determine from the existing literature, previous surveys, personal contacts and other related sources what information exists with regard to state-of-the-art findings and instructional theory directly applicable to the problem of developing instructional strategies for computer-assisted team training.

Procedures:

In order to develop a conceptual framework for deriving $COLT^2$ instructional strategies, three major elements were identified and integrated into a framework which will be further refined in subsequent efforts. These elements are identified as:

(1) Team task dimensions and team training objectives

(2) Learner characteristics and strategies

(3) Characteristics of the training delivery system used to implement the strategies.

Team task dimensions were identified by examination of team training literature and through discussions with individuals involved in team training. The team task dimensions were organized within a four-step model for task analysis. Task analysis along the selected team task dimensions allowed for the derivation of team training objectives which were then used to generate the five categories of team learning. The team learning categories will be used in the development of team training instructional strategies.

Learner characteristics and strategies are important to $COLT^2$ instructional strategies in that they define student-entry behaviors, expectations of how students will behave while learning a team task, and variations in how students process or seek information. These characteristics/strategies were defined in terms of a model of the team learner rather than the individual. Since the model of the team subject matter, based on the results of the team task analysis, and the model of the team learner will be interdependent, the five categories of team learning were also used to classify characteristics and strategies in the literature which may be relevant in deriving $COLT^2$ instructional strategies.

Computer-assisted instruction (CAI), as an instructional media form, is a set of programmed components for presenting information, providing student interaction, monitoring student progress, and manipulating the sequence of instruction. Specification of system capabilities in these terms defines

CAI modes and CAI techniques and, hence, CAI instructional strategies. A set of skeleton procedures for relating CAI system capabilities, modes, and techniques to COLT^2 instructional strategies was developed.

Findings:

Two major conclusions resulted from the state-of-the-art assessment of instructional strategies for team training: (1) A conceptual framework for a general purpose set of instructional strategies for team training does not exist. Hence, the attempt in this report is to provide an organization for evolving such strategies. (2) An Instructional Systems Development (ISD) approach to team training must be developed.

Utilization of Findings:

The information contained in this interim report provides a starting point, or baseline, from which subsequent efforts to develop a full-fledged COLT^2 system will evolve. The report uses this baseline as a point of departure and presents a delineation of the general instructional problems to be dealt with in developing team training. Specifically, the report outlines the important factors to be considered in developing <u>computerized</u> team training.

CONTENTS

TABLES

INTRODUCTION

An important project done in the area of training and education by the Army Research Institute for the Behavioral and Social Sciences is the analysis, development and evaluation of: (1) learning strategies which take into account the unique factors involved in the training of personnel who must learn to operate as an integrated team and (2) a demonstration of the capability to automate this interactive team training process. This report describes that first step, (Task 1) by presenting the results of a state-of-the-art assessment of instructional strategies for computerized collective training for teams, which we have designated COLT^2. The goal of Task 1 was to determine from existing literature, previous surveys, personal contacts and other related sources, the information which exists with regard to state-of-the-art team training instructional strategies. Further, Task 1 efforts were directed toward an examination of instructional theory to determine what if any, information was available which would be applicable to the problem of developing instructional strategies for COLT^2.

The information contained in this report provides the baseline from which four subsequent research tasks will evolve:

- Task 2 involves the derivation and development of instructional strategies for COLT^2. Specifically, the objective of this task is to derive historically, analytically and empirically a conceptual framework, fleshed out with detailed principles, for a general purpose (non-job or system-specific) set of instructional strategies applicable to team training problems in a computerized setting. Task 2 shall be a continuing, parallel development to Tasks 3, 4, and 5 to ensure a constantly modified and fine-tuned framework.

- Task 3 requires conducting a detailed job/task and training analysis for two classes of team training: (1) the man-computer-man paradigm and (2) the man-(non-computer) man setting.

- Task 4 is the development of a team training lesson scenario for instructional strategy assessment. The objective of this task is to develop a scenario based on the stages and sequencing represented in the job/task analysis (Task 3) integrated with the team training instructional strategies (Task 2) to produce a training scenario.

- Task 5 is the development and demonstration/evaluation of a "brassboard" computerized team training system which ties meaningful aspects of the preceding tasks together.

It is anticipated that the outcome of the COLT^2 work will be a method for producing and conducting computerized team training. COLT^2 products will be generic in that (1) the instructional strategies developed should be of use wherever team training is of concern and (2) the conduct of COLT^2 will be of use in computer systems where team interactions among operators is a matter of concern. That is, it will be one aspect of an Instructional System Development (ISD) for team training.

The target test bed for the COLT^2, assuming successful outcome of the effort, is a computerized artillery fire control system called TACFIRE (Tactical Fire Direction System). TACFIRE is a complex network of interconnected computers located at various command levels. Each computer, under the direction of an operator, participates in two-way exchanges of tactical data bases and other artillery intelligence data. In addition, remotely located input/output devices are used to query and update various data bases. Effective use of TACFIRE requires that the operators be well trained as individuals but it is also crucial that each operator be trained regarding the functional interrelationships among the various operators in TACFIRE if the system is to be maximally effective. It is this latter aspect that the COLT^2 work addresses. The COLT^2 effort is designed to study this training problem using TACFIRE as its frame of reference, and to extract from this research a generic framework which should provide a foundation for developing and implementing COLT^2.

The body of this report is organized into three major sections, each addressing the state-of-the-art assessment of instructional strategies for COLT^2 from a different vantage point. A brief overview of each section is provided here.

Team Task Dimensions. The dimensions of a team and its tasks must be clearly defined before the instructional strategies for the team can be derived. Such definitions appear to have been a major block to date. However, a variety of team dimensions are discussed in the literature or have actually been the focus of team training by military instructors. These dimensions include coordination, communication, decision processing, self-evaluation, team awareness, team pride, and others. The team task dimensions which have been determined to date as being critical are defined in this section, with reference to the relevant research literature when available or known. In addition, these potential team task dimensions have been organized within a four-step model for task analysis. This will allow testing the amenability of these dimensions toward deriving instructional strategies related to training objectives.

Learner Characteristics and Strategies. All instructional strategies must take into account the characteristics of the learner, including his/her strategies for self-management of learning. CAI strategies for individual training extensively and explicitly build up on these student characteristics. For example, techniques for branching, adaptive, and optimized instruction make decisions about sequencing and other strategy variables based on the student's permanent or trait and situational or state characteristics. A major portion of the characteristics within both categories, trait and state, relate to the strategies which may be used by a learner to select, organize, retrieve, or process information. Emphasis is given to some of the learner strategies which may potentially relate to $COLT^2$ in the belief that an ISD designer cannot manipulate the instructional environment without consideration of the learner's manipulations. This principle may be especially relevant to a team environment which involves cooperation and coordination; that is, strategies for both cooperation and coordination may be required by an individual.

CAI Capabilities. The instructional strategies used in CAI, whether for individuals or teams, are a function of the system's capability to (1) present information, (2) sequence instruction, (3) take student responses, and (4) measure progress. Specification of the system's capability in these terms defines the CAI mode and techniques (i.e., the instructional strategies). The CAI mode, in turn, is related to overall instructional techniques such as drill-and-practice, tutorial, or simulation. These CAI techniques may be described as sets of specific instructional manipulations under programmed control (e.g., as in adaptive, paced, or learner controlled instruction). CAI techniques are dependent on the media characteristics, both hardware and software, of the system. A set of skeleton procedures will be provided in this section of the report to relate team task dimensions and learner characteristics/strategies to CAI capabilities, modes, and techniques.

TEAM TASK DIMENSIONS AND ANALYSIS

Two recent reviews of team training (Hall and Rizzo, 1975; Wagner, Hibitz, Rosenblatt, and Schulz, 1976), one for Navy training and the other for the Defense Advanced Research Projects Agency, both centered on the difficulty in defining teams and team training. As noted by Hall and Rizzo, "no one seems to be able to articulate its [team] dimensions with sufficient clarity to permit the development of training procedures for producing it. Neither can anyone decide, unequivocally, if a team is simply a collection of individuals performing separate task jobs in a group context, or if there are unique trainable team skills that exist over and above individual functions." Both of the reviews noted the distinctions between teams and small groups offered by Klaus and Glaser (1968).

> "A team is usually well organized, highly structured, and has relatively formal operating procedures - as exemplified by a baseball team, an aircraft crew, or ship control team. Teams generally:
>
> 1. are relatively rigid in structure, organization, and communication networks,
> 2. have well defined positions or number assignments so that the participation in a given task by each individual can be anticipated to a given extent,
> 3. depend on the cooperative or coordinated participation of several specialized individuals whose activities contain little overlap and who must each perform their task at least at some minimum level of proficiency,
> 4. are often involved with equipment or tasks requiring perceptual-motor activities,
> 5. can be given specific guidance on job performance based on a task analysis of the team's equipment, mission or situation."
>
> "A small group on the other hand is rarely so formal or has well-defined, specialized tasks--as exemplified by a jury, a board of trustees or a personnel evaluation board."

The criteria for team definition appear to be (1) rigid structure, organization, and communication networks, (2) anticipation of an individual's task participation by virtue of well-defined assignments, and (3) cooperation or coordination.

Other definitions of teams would seem to generally agree. Some of these are:

1. "A task-oriented organization of individuals interacting to achieve a specific goal." (Horrocks and Goyer, 1959)

2. "Two or more operators working in a structured and task or goal-oriented environment." (Briggs and Naylor, 1964)

3. "A synthetic organism with individuals as components." (Alexander and Cooperband, 1965)

4. "It is considered to be relatively rigid in structure and organization with well defined number of tasks, roles, and communication links." (Klaus and Glaser, 1970)

5. "Three or more persons working in concert toward a common, identifiable and relatively immediate goal." (Daniels, Alden, Kanarick, Gray and Reuge, 1972).

Based on such definitions, the Hall and Rizzo report stated that the following criteria should be used to determine whether team training is applicable:

1. A team is goal or mission oriented.

2. A team has formal structure.

3. Members of a team have assigned roles which are well defined.

4. A team has required interaction between members.

If the criteria for team training are to be useful, one should be able to derive the dimensions of a team which is trainable from these definitions of a team.

TEAM DIMENSIONS

These criteria represent the global dimensions of a team. More detailed, operationally usable dimensions are required. Some potential dimensions, mentioned in the literature and discussed by team training instructors, should be analyzed for any team training effort to determine if they are applicable. For example, one may see or hear the terms cooperation, communication, coordination, team awareness, self-evaluation, anticipation, team pride, confidence, aggressiveness, and decision processing; but are these terms a part of every team training task situation?

The first step leading to a systems approach for team training ISD must be to determine and define team task dimensions that can be used in task analysis and that eventually lead to appropriate instructional strategies. To this end, the dimensions which have been identified to date are related to the criteria for team training listed above. Descriptions are provided in the following paragraphs.

Self Evaluation. Self-evaluative skills are discussed in the literature as being important in team training because an effective team member must learn to determine when an overload point has been reached and assistance is required from another (Boguslaw and Porter, 1962). This skill requires the analysis of one's own errors as well as knowledge of team mate's errors so that the overload condition can be ameliorated. Self-evaluation is related to the team definitions of well-defined assigned roles and team goals becuase evaluation cannot occur without these criteria.

Team Awareness. Team awareness centers on the knowledge of a team member about the roles of each team individual in relationship to the need for effective communication and interaction (Kanarick, Alden, and Daniels, 1971). That is, team awareness is knowledge of the relationships among tasks by team members. Team awareness, as a task dimension, is related to the criteria of assigned roles which are formal and structured. As knowledge oriented learning, this dimension should be fairly easy to measure and train. However, whether this dimension is necessary to train to is not clear from the literature in that no studies were found which directly addressed the issue of effectiveness.

Team Attitudes. The terms pride, confidence, and aggressiveness did not appear in the literature, but were obtained from discussions with instructors involved in team exercises. The instructors indicated that an individual must learn confidence in his abilities as an individual and then learn aggressiveness in his coordination, especially in communication. For example, it may be necessary for a subordinate to interrupt a superior when he receives critical information. If relatively young, low-ranking personnel do not achieve this confidence and aggressiveness, the team effort will be debilitated. Subordinates, to be effective, must understand the team mission or goal and their assigned roles for interacting to achieve the goal. The discussions with the instructors also indicated specific attempts to train these qualities. Among the strategies used were imitation, demonstration, or pointing to a team member who demonstrated the quality.

The dimension of pride in the team was discussed in regard to the relationship of sub-team performance to that of the full team. The instructors were asked their opinions on whether there was a difference in the training of sub-teams as opposed to full team training. Responses from instructors indicated that sub-teams must be trained along specific team dimensions, including pride in the team. However, once pride in the sub-team is established then sub-teams will adjust themselves to operating as a team to achieve the same characteristics.

Communication. Two dimensions, communication and decision processing, are directly related to the team-defining criteria of interaction among team members. Both dimensions seem to be large areas that may have sub-dimensions and that promise to allow more instructional strategies to be derived both from the literature and in a logical/deductive manner. It is interesting to note that while communication is prominently mentioned in coordination in the reviews cited earlier, little discussion centers on the types of communication or its exact relevance to team training. This shortcoming is due more to a lack of literature, both theoretical and empirical, than to neglect on the part of the reviewing authors.

While communication is discussed as a coordination task for teams, generally the research and theory do not immediately allow for deriviation of team communication definitions or strategies for teaching. Two studies demonstrate that communication is an important part of a coordination task and training of such coordination skills develops more effective performance in a team. Johnston (1966) studying two-person teams in a simulated radar situation compared team coordination skill training to individual training with a criterion task requiring coordination. The findings indicate that performance was more effective when the coordination skill training was given. In another condition verbal communication was not required and, as might be expected, the coordination training had no effect on final performance. McRay (1966) similarily found that coordination training for communication produced more effective team performance than did individual training alone. Willeges (1966), however, found that when two channels of communication, verbal and visual, were allowed the verbal communication training had no effect on team performance. Findings by Federman and Siegel (1965) are related to those of Williges. In their study of team communication, the transmission quality of the primary sensing data (in this case sonar information) influenced the team's performance in both communications and decision making. These studies suggest that a team task analysis must take into account the use of more than one channel of communication and the quality of that channel in a coordinated task.

A study which provides additional insights into types of team communication, especially as applied to coordinated tasks, is that of Federman and Siegel (1965). The study investigated the relationship between anti-submarine warfare helicopter team performance and the content and flow of communications within the team during an attack. Fourteen different communication variables were found to be correlated with an objective performance measurement criterion (miss distance). A factor analysis of the fourteen communication variables resulted in four factors being identified: (1) probabilistic structure, (2) evaluative interchange, (3) hypothesis formulation, and (4) leadership control. The factors demonstrate the close relationship between communications and decision processing. As defined by the authors of the study, probabilistic structure "is marked by situations in which extrapolations contain the thought processes involved in weighing alternatives, and in questioning and searching for answers to questions. Evaluative interchange is contained in communications in which there are direct requests for information and opinion, as well as the responses to these requests. Hypothesis formulation categorizes those communications involving interpretations of past performance in the mission and evaluation of the future tactics to be followed. Leadership control describes communication marked by a role-assuming attitude; it serves to define goals and set assumptions for decision making." The authors suggest that their findings be translated into questions regarding the training of teams. Questions associated with the four factors are:

"1. Do the crew members express tentative amplifying reports which invite collaboration in the determination of group decisions?

2. Does a team employ a free interchange of opinion of situational factors in the problem?

3. Does the team reflect a flexible weighing of alternatives by means of an active question and answer attitude toward problem solution?

4. Does the leadership permit high risk behavior which may result in problem failure?"

While the study does not directly address training for these types of communication-oriented coordination tasks, the results suggest that the correlated communications variables are team task dimensions which should be part of a task analysis. The communication variables will be used in Task 3, the job/task analysis, to test their applicability as task dimensions for deriving instructional strategies.

Decision Making. If it is really a team dimension, decision making would appear to be tied to the criteria of required interaction. While decision making is often discussed as an integral attribute of teams, at least one report (Hall and Rizzo, 1975) leaves open the question of whether tactical decision making is actually a team effort. Hall and Rizzo, after reviewing definitions of tactical decision making, concluded that the process involves four components: (1) situation diagnosis, (2) hostile environment, (3) selection of optimum alternatives, and (4) some degree of uncertainty. Further, Hall and Rizzo concluded that they "do not consider tactical decision making to be a team behavior, per se, but rather view it as an individual function." The resolution of whether decision making is a team or individual effort may be found in the type and quantity of communication involved. All four factors of the communication variables found by Federman and Siegel are related to decision processing and reflect different types of communications used in acquiring information for decision making. While the actual decision may be made by an individual, the communications, whether initiated by an individual or as a coordinated effort, do influence the decision making. For this reason, decision making has been considered as team dimension in the present effort. However, when analyzing the task decision making must be considered to be more a part of the previously discussed types of communication.

TEAM TASK ANALYSIS

If the team task dimensions above are to be useful in deriving instructional strategies, procedures must be developed for task analysis. Folley (1964) developed guidelines for task analysis which included consideration of a team task. The team task dimensions did not include all of those discussed here. The guidelines are of interest, however, to provide a framework for expansion to a more comprehensive team task analysis approach. Folley defined four stages in task analysis, as in Table 1, which are associated with the units and data found in Table 2. One of the interesting aspects of Folley's system is that the procedure begins with a whole system and proceeds to smaller component levels within the system down to the activities within a task. This arrangement lends itself to a team task analysis because the team functions may be analyzed from the top level down to individual behaviors.

System Block Analysis. In the first stage, a system block analysis identifies groups of tasks, which may include several positions and equipments, that are directed toward the same subgoal in a system operation. For example, "process outputs for a fire request" in TACFIRE would involve the positions of a console operator and fire direction officer, as well as the artillery control console. The group of tasks involved represents a man-computer-man interaction to achieve a team goal.

Task-Time Charts. In the second stage, task-time charts are developed by (1) identifying the task and determining which person (position) performs each, (2) determining typical task duration and coordination requirements, and (3) determining the adverse conditions which simultaneously affect some or all of the tasks in the block.

The task duration and coordination requirement (number 2 above) is of major interest to a team task analysis because it is the point at which team dimensions, such as communication, are determined. The task-time charts will show the tasks in relationship to each other. For example, some tasks will be performed in series, while others can and/or should be done simultaneously. The coordination requirements are determined concurrently with the establishment of time relationships for tasks. Folley suggests two questions which may be asked to determine whether coordination is required.

1. "May the task performer have to modify what, how, or when he performs his task because of the way someone else performs another task at or near the same time?"

2. "May someone else, performing a different task at or near the same time, have to modify what, how, or when he does it because of the way the performer of this task performs his task?"

If a positive answer is reached for either of these two questions, then additional information must be obtained. The additional information is of two types. The first type of information is concerned with identification of other tasks which require coordination with the task being described. The second type of information concerns the nature of the required coordination. Coordination, in Folley's approach, is described in two ways: kinds of coordination and closeness of coordination. The two kinds of coordination are: (1) physical, as when two people lift something together; and (2) communication, "As when one task performer must provide information to the other to achieve performance of a task." The second is of more concern to team training within the context of the present study.

Folley also defined three categories of closeness of coordination. The first type of closeness, start-finish coordination, is illustrated in situations in which performance of a task must wait until a specified cue is received from another task. For example, the TACFIRE artillery control console operator must receive a fire request message before coordination with fire direction officer. The second category of coordination closeness is discrete feedback, when several interchanges of cues

TABLE 1

FOUR STAGES OF TASK ANALYSIS (Folley, 1964)

STAGE 1: SYSTEM BLOCK ANALYSIS

Objective - Identify groups of tasks by subgoal in a system operation

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STAGE 2: TASK-TIME CHARTS

Objectives - (1) Identify tasks and determine performing positions

(2) Determine typical task duration and coordination requirements

(a) Determine coordination requirements by two questions
-may task performer modify performance because of another's performance?
-may another task performer have to modify a task performance because of this performer?

(b) If the answer to either question in (a) is yes:
-determine task or tasks in coordination
-determine nature of coordination
physical
communication
-determine closeness of coordination
start- finish
discrete feedback
continuous feedback

(3) Determine adverse conditions

STAGE 3: FUNCTIONAL TASK DESCRIPTION

Objectives - (1) Determine time performance requirements
(2) Identify kinds of activities with time relationships among activities
(3) Determine proportion of time for each activity in task
(4) Identify contingencies which may disturb performance
(5) Identify adverse conditions for each activity

STAGE 4: BEHAVIORAL DETAILS DESCRIPTIONS

Objective - Determine behavior and other components required for each activity

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TABLE 2

STAGES IN TASK ANALYSIS AND SCOPE AND KIND OF DATA

OBTAINED IN EACH STAGE (FROM FOLLEY, 1964).

Phase	Units within which data is obtained	Kind of data obtained
Development of:		
1. System block analysis	Whole system	Major system operations; arranged according to sequence and time, when possible
2. Task-Time charts	Operating stages or whole system	Identification of tasks and relationships among tasks
3. Functional task descriptions	Tasks	Activities within tasks and relationships among activities
4. Behavioral details descriptions	Activities in tasks	Psychological characteristics of activities

or information are needed between performance of tasks. The feedback is discrete because the information passed between positions is discrete: "Although the information from one task may affect the performance of another, it will not require continous adjustment to continuously changing cues." The third category of coordination closeness is continuous feedback where the performer of one task receives a continuous set of information from the performer of another task and continuously adjusts his performance according to the information. For example, position coordinates of an enemy vehicle which are continuously updated will cause a manual plotter to adjust the position on his board.

Functional Task Description. While the task-time chart determines the relationships between identified tasks, the next step in Folley's approach, functional task description, is oriented toward describing the activities within a task and the relationships among those activities. The functional task description is applied at the man or man-machine level as opposed to the first two steps which are at the system and team level. The functional task description brings the task analysis one level deeper than the task-time chart. These procedures can be applied to a particular task and position which has been identified as requiring coordination, including communications, as well as to an individual task without associated team dimensions. The functional task description, as defined by Folley, has five objectives:

(1) Determination of the time performance requirements of the task.

(2) Identification of the kinds of activities (procedure following, perceptual motor activity, monitoring, communicating, decision making, or other) showing the time relationships among activities.

(3) Determination of the proportion of time for each activity in the task.

(4) Identification of contingencies or occurrences that may disturb expected performance.

(5) Identification of adverse conditions possible for an individual task.

Behavioral Details Description. The final stage in Folley's approach is the preparation of the behavioral details descriptions. This stage of the analysis results in the greatest detailed information. It is here that the types of individual activities identified in the functional task description, including those which are part of a group of tasks requiring coordination, are defined further. For example, in a task which is defined with communication, the media, such as radio or oral, will be identified. The detailed descriptions should provide information directly related to design of instructional strategies including: (1) "estimating the capability of input students to perform the tasks;" (2) "estimating the difficulty of the training problem associated with each task;" (3) "estimating the level of performance that can be expected after training." The first two estimations will be used to determine such strategy variables as levels of difficulty, pacing, organizers, and sequence. The third estimation is directly related to the criterion performance measures, called job performance measures in the Interservice Procedures for Instructional Systems Development (Branson, Rayner, Cox, Furman, King and Hannum, 1975) which determine success or failure of instructional strategies and possible requirements for strategy revision in the case of failure. In Tasks 2 and 3, the team training instructional strategy derivation and the job/task analysis respectively, the factors required from the behavioral details description will be added to and refined in order to directly relate team task dimensions to design of instructional strategies for $COLT^2$.

FURTHER DEVELOPMENT OF TEAM TASK ANALYSIS

In addition to the expansion of Folley's guidelines, which will be developed during the subsequent tasks in the study, the assessment of team task dimensions described earlier provides some immediate suggestions for modification. Taking the criteria for defining teams into account, it may be desirable to include statements of team goals and the formal structure of the positions/machines in Stage 1, the system block analysis. Such statements should aid in determining strategies for dimensions of self-evaluation, team awareness, team pride, and the others identified earlier.

Consideration of team research, theory, and practice with dimensions requiring coordination beyond those cited by Folley should be added to Stage 2, the task-time charts. A preliminary list, which includes all of the team dimensions discussed earlier as well as the names of the fourteen communication types found to be correlated with a team task performance measure by Federman and Siegel (1965), is shown in Table 3. It should be noted that, according to the list in Table 3, all team task dimensions are subsumed under coordination.

Folley's guidelines require additional information to be determined if coordination is identified. Based on the previous discussion of research on communication, it is suggested that two types of information be added. First, is more than one channel of communication possible? If so, one may be more important to train to than another. Secondly, what is the quality of the communication channel? The behavioral details description may change depending on whether the channel is poor or high quality; for example, one may expect more requests for information with a poor quality channel.

CATEGORIES OF TEAM LEARNING

As part of the development of a systems approach to team training ISD, consideration must be given to categories of team learning. After team training objectives are established from the output of the team task analysis, they will be classified and grouped into categories of team learning to facilitate the identification of appropriate instructional strategies. It may be that team task dimensions, in whole or in part, can be used in categories of team learning. A review of several previously developed classification schemes and their implications for $COLT^2$ is provided in the following paragraphs.

TABLE 3.

REVISION TO COORDINATION TASK ANALYSIS, AS DEFINED BY FOLLEY, TO INCLUDE ADDITIONAL TEAM TASK DIMENSIONS.

STAGE 1: SYSTEM BLOCK ANALYSIS

Add to the objectives:
(1) Define the team mission or goal(s)
(2) Define the formal team structure

STAGE 2: TASK-TIME CHARTS

(1) Under 2(b) of Table 1 add to nature of coordination:

If communication is required, (a) Is there more than one channel, and (b) What is the channel quality?

Communication*

- Activity messages
- Evaluative messages
- Confusion risk willingness /reluctance
- Directing messages/requests for messages
- Unrequested messages
- Phenomenological messages
- Invitational messages
- Phenomenological and invitational messages/objective messages
- Progressive messages/regressive messages
- Requests for information
- Provides information
- Requests for opinion
- Provides opinion
- Voluntary opinion

Self-evaluation
Cooperation
Decision processing
Problem solving
Team awareness
Pride
Confidence
Aggressiveness

STAGES 3 and 4: Same as in Table 1

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*As defined by Federman and Siegel (1965)

Faust (1976), in describing a current effort in team training design for the Navy, relates that a major assumption of the instructional development approach is that "...objectives can be classified by content and behavior (e.g., student response) and these classifications aid in the selection of instructional strategies." The simplified objectives classification matrix used by Faust has four content and two student behavior categories; that is, facts, concepts, procedures, and rules can be taught in such a way that the student can remember and/or use them. The matrix is exemplified by Faust in the context of familiarization training of a position for other team members. By using the remember category of student behavior and the set of basic strategy components that is specified and sequenced for each cell in the matrix, instructional strategies that may have application to team training can be derived.

Folley's guidelines for task analysis also include a classification scheme for kinds of activities within a task. In Stage 3--the functional task description--the activities within a task, without regard to whether coordination is required, are identified as one of six kinds. These are defined as: (1) procedure following; (2) continuous perceptual motor activity; (3) monitoring; (4) communicating; (5) decision making or problem solving; and (6) non-task related. In Stage 4--the behavioral details description--the definition for each kind of activity is broken down into specific examples and action verbs are included. These definitions could be used to group and classify training objectives that are developed as a result of the task analysis, as well as during the task analysis to describe the behaviors that are to be trained.

Twelve learning guidelines and algorithms that identify fundamentally different types of training objectives for military tasks have been incorporated into a technique for choosing cost-effective instructional delivery systems (Braby, Henry, Parrish, Swope, 1975). Each of the algorithms is associated with the characteristics of training objectives in terms of action verbs, behavioral attributes, and examples. Block III.1 (specify learning events/activities) in the Interservice Procedures for Instructional Systems Development (Branson, et al., 1975) provides a description of training task categories. Eleven of the twelve algorithms identified by Braby, et al. (1975) appear as subcategories within four learning categories:

LEARNING CATEGORY	SUB-CATEGORY
1. Mental Skill	1. Rule Learning and Using, Classifying - Recognizing Patterns, Identifying Symbols, Detecting, and Making Decisions
2. Information	2. Recalling Bodies of Knowledge
3. Physical Skill	3. Perform Gross Motor Skills, Steering and Guiding Continuous Movement, Positioning Movement and Recalling Procedures, and Voice Communicating
4. Attitude	4. Attitude Learning

Considering these task categories for individual training objectives in light of the potential team task dimensions described earlier, certain inferences can be drawn. For example, the sub-categories of decision making, voice communicating, and attitude learning lend themselves to the inclusion of team task dimensions.

Taking into account the list of task dimensions proposed for analysis in Table 3 and each of the above categories of learning, a tentative list of five team-task learning categories has been derived for the purpose of the remaining tasks in the present study. These are communication, knowledge of team roles, decision processing, problem solving, and team attitudes. All types of communication tasks in Table 3 have been subsumed under the one learning category of communication. Since the types of communication vary considerably, additional categories may be needed eventually and this will be determined in large part by the job/task analysis and scenario developments later in the study. Self-evaluation, cooperation, and team awareness have all been placed under the learning category, knowledge of team roles. Each of the three task dimensions requires knowledge of the team formal structure, team goals, and team members. Decision processing and problem solving each seem to be categories in and of themselves, although, as discussed earlier in the chapter, they may be so tied to communications that separate team task dimensions, and therefore team learning categories, are not required. Finally, pride, confidence, and aggressiveness have each been categorized as the learning of team attitudes.

These five learning categories provide the link from the team task analysis to derivation of COLT^2 strategies. The categories will be used to classify team training objectives as well as learner characteristics and strategies. This will facilitate the organization and elements of COLT^2 instructional strategies.

LEARNER CHARACTERISTICS AND STRATEGIES

The purpose of this chapter is to describe the importance of learner characteristics and strategies to COLT^2, summarize the state-of-the-art relevant to COLT^2 strategies, and develop a framework for continued efforts in deriving COLT^2 strategies based on learner characteristics. Generic to all ISD models is a component which requires description of the student-entry behavior. This requirement usually comes after job/task analysis, development of objectives, and development of tests. This is true also of the Interservice Procedures for Instructional Systems Development (Branson, et al., 1975). As noted in Volume 2 of the Interservice Procedures the entry behavior includes the skills, information, and attitudes that characterize an individual at the time of instruction. The student-entry behavior defines the limits of the instruction and any required remedial or preparatory instruction. The description of entry behavior must be performed for a COLT^2 situation as it is done for individual instruction. Not only does an analysis of the learner's entry characteristics tell the instructional designer where to start the instruction and whether remediation is necessary for some or all students, but such characteristics are the basis for many strategies used in CAI such as branching, adaptive, optimization, adaptive testing, and others.

In particular, one class of characteristics is the strategies which a learner will use during instruction. Learner strategies include the methods used by a learner to seek out information, to retrieve the information, and to use the information for making decisions and problem solving. All of these strategies of the learner may be required in a team task as well as an individual task. In addition, the team task may have unique learning demands when for example, the learner is required to assess the roles of other positions and develop techniques for cooperative behaviors such as in the task dimensions of self-evaluation and team awareness discussed in the previous chapter. Given knowledge of the possible student strategies for learning, instructional strategies may be designed to allow, restrict, eliminate, or facilitate a given student strategy. Thus, instructional strategies are designed, in part, on the basis of learner characteristics and learner strategies.

As noted by a recent review on learner strategies (Dansereau, Actkinson, Long, and McDonald, 1974) extensive efforts have been directed at improving teaching methods, including development of instructional strategies, but few attempts have been made at developing a basis for improving learner strategies. The conclusion reached in the present study is that learner strategies need to be developed in parallel with instructional strategies, and that each will influence the other. This is in agreement with Dansereau, et al. (1974).

In summary, some of the important aspects of learner characteristics and strategies for $COLT^2$ strategies are:

(1) They are entry behaviors which will influence the content and sequence strategies used in $COLT^2$;

(2) They define expectations, which the $COLT^2$ instructional strategy must account for, of how a student will behave during the learning of a coordination task;

(3) They define variations in how a student processes information, such as might be given in team communications, or seeks information for self-evaluation and team awareness;

(4) They allow instructional strategies which teach the learner appropriate strategies for identifying the goals of the team, selecting and analyzing the information in team communications which will most effectively meet team goals, and analyzing the individual member's role in the team.

APPROACH

The approach toward identifying learner characteristics and strategies taken here is closely related to a distinction by Alexander and Cooperband (1965) between two team training models. They described the research on team behavior as being oriented either toward a stimulus-response or an organismic model. The stimulus-response model attempts to apply principles of individual learning, such as those found in operant conditioning, to team training. The organismic model considers the team to be a synthetic organism composed of individuals. The latter approach has been stressed in this report in describing team task dimensions. The organismic model is again used in discussing the relevance of learner characteristics and strategies to COLT^2 strategies because the prime concern is with tasks involving several individuals which require coordination and cooperation. The characteristics of individual students which will affect such tasks are taken into account only within the context of the team operating as a whole.

In the team task analysis, the dimensions were derived at the system/team level and sublevel (Stages 1 and 2 of the model). The behavioral details of an individual were not considered directly relevant to team training per se. Such is the case for learner characteristics. The learner must be described in terms of the characteristics which are related to a model of the team not the individual. Fletcher (1974) has described models of the learner used in CAI and surveyed some of the techniques for instructional strategies which are associated with the models. CAI models of the learner are all oriented toward the individual. A team learner model must be developed. As pointed out by Fletcher (1974, 1975), CAI models of the learner imply models of the subject matter and the two are so interdependent that there may be little reason to distinguish between them. A model of the team learner must be based on the same results.

The structure which is used here toward developing a model of the team learner is the same as the model of team subject matter. That is, the learning categories used to classify team training objectives are used to model both the subject matter and the learner. As described in the chapter on team task dimensions and analysis, the learning categories used as a strawman conceptual framework in the study will be communication, knowledge of team roles, team attitudes, decision processing, and problem solving. The team task dimensions and objectives are subsumed under these categories of learning in Chapter 2 and the categories will be used here for classifying learner characteristics and strategies.

In the remainder of this chapter some specific learner characteristics and strategies are discussed with speculation on how they might relate to COLT^2. No theory or research literature has been found to date that directly addresses the relationship of these variables to team training strategies. However, their general importance to a team training ISD set of procedures and to COLT^2 strategies in particular warrants developing a framework for further analysis. Such analysis will continue in the remainder of the study. It should be noted that a parallel study on small group dynamics related to team training is in progress. The study is sponsored by the Office of Naval Research and being performed by Dr. John Collins of Essex Corporation. This study is focusing on the development of a set of interrelated descriptors of small group behavior. It is anticipated that this effort will allow for the systematic expression of the interrelationships of social variables that affect the behavior of small groups. The study is not concerned with training per se, but the results certainly should be of value in team training efforts such as COLT^2. The results of the Essex study will be integrated at a later date as applicable and as data is available.

LEARNER CHARACTERISTICS

For the purpose of illustrating the relevance of student characteristics to $COLT^2$, emphasis will be given to some characteristics which may impact on the ability of the student to process communication in a cooperative, coordinated task. The process of determining characteristics relevant to $COLT^2$ strategies must continue for communication as well as all other team learning categories. In this way a model of the learner will be tied to a model of the subject matter and allow derivation of $COLT^2$ strategies.

Learner characteristics may be used as a basis for a $COLT^2$ strategy with preprogrammed decisions or for teaching the learner strategies to use during $COLT^2$. To some extent, consideration of state characteristics, such as the score on the last test or current state of anxiety, departs from the concept of entry behavior description because the measures may be used as dynamic indicators of a learner state. However, the discussion, to be relevant to $COLT^2$, must allow both for analysis of learner characteristics which will be used in designing instructional strategies and those which will be used during the instructional manipulation in a real-time, dynamic, interactive mode.

Dansereau, et al. (1974) identified the following factors which potentially affect a learner's choice of strategies. Many of the same characteristics have been used in CAI strategies for selecting content, sequencing, and pacing. These characteristics categories are intellectual aptitude and the availability of strategy skills, personality variables, cognitive style, reception preferences, motivation, sex, and prior knowledge. The research on each of these factors is too extensive and diverse for even a brief summarization to be included in this document, but examples of some salient findings will be discussed. The purpose in discussing these examples of learner characteristics is to demonstrate how the general literature may be used to generate hypotheses concerning learner characteristics and $COLT^2$ strategies within the conceptual framework presented here.

Intellectual Aptitude and Availability of Strategy Skills. Several examples that relate the learner characteristic of intellectual skills to the categories of team learning discussed earlier are provided.

Learning Category - Knowledge of Team Roles. Conceptual complexity, the capacity to integrate and interrelate dimensional units of information, is an intellectual aptitude that can be measured (Schroder, Driver, and Steufert, 1967). Intellectual aptitude appears to be an important factor in determining the types of learner strategies upon which an individual can call. The characteristic might be considered for training team members to integrate information about team member roles in relation to the team goal. Research suggests that conceptual complexity can be manipulated through training (Sieber and Lanzetta, 1966; Solomon, 1968).

Learning Categories - Decision Processing, Communication. Dansereau, et al. (1974) employed the structure of the Intellect Model (Guilford and Hoepfner, 1971) as a framework for discussing the availability of learner strategy skills. In the model, the following five intellectual operations have been identified by factor analysis of a large variety of paper and pencil tasks:

(1) Cognition - Immediate discovery, awareness, rediscovery, or recognition of information in its various forms, comprehension or understanding;

(2) Memory - Fixation and retrieval of information in storage;

(3) Divergent Production - Generation of logical alternatives from given information, where emphasis is upon variety and quantity;

(4) Convergent Production - Generation of logical conclusion from given information, where emphasis is upon achieving unique or conversationally best outcomes;

(5) Evaluation - Comparisons of items of information in terms of variables and making judgments concerning criterion satisfaction.

Research indicates that the ability to perform these operations strongly relates to achievement (Guilford, Hoepfner, and Peterson, 1965; Dunham, Guilford, and Hoepfner, 1968; Caldwell, Schroder, Michael, and Meyers, 1970). The structure of intellectual operations may correspond to the basic skill components required for the development and implementation of learner strategies. For this reason, the intellectual operations correspond directly with the categories of learner strategies developed in a subsequent section of this report. These characteristics offer face validity as relevant to a team member's ability to process the information communications in either a man-man or man-computer-man situation.

Personality Variables. Three examples are provided to illustrate the influence personality variables may have on team performance.

Learning Category - Communication. Dogmatism and tolerance of ambiguity primarily influence strategy selection in tasks involving the manipulation of ambiguous or belief discrepant information (Rokeach, 1960; Feather, 1964). The characteristics could be useful for communication training involving risk willingness or reluctance as defined by Federman and Siegel (1965) and discussed earlier in the section on team dimensions.

Learning Category - Communication and Decision Processing. A measure of the personality construct, locus of control, was developed by Rotter (1966). The construct itself is viewed as a generalized expectancy about control over the environment with a wide variety of situations included within the spectrum of generalization. Internal control refers to the individual's belief that an event is contingent on his/her own behavior or characteristics. On the other hand, an individual characterized by external control attributes the occurrence of a significant event to fate, luck, or to the control of others or as being unpredictable (Rotter, 1966). Judd, O'Neil and Spelt (1974) conducted an extensive review of the research that has appeared since Rotter's initial formulation. The research indicates that the external subject requires more specific guidelines than the internal subject in order to perceive his own needs and take the opportunity to control. It also appears that increasingly well-defined task instructions provide a missing cognitive link for external subjects which helps them to improve their performance. The locus of control characteristic may assist, therefore, in defining instructional strategies for adapting the feedback and prompting to team members during $COLT^2$ communications - especially those associated with decision processing.

Cognitive Styles. Dansereau (1974) discusses cognitive style as a characteristic which creates boundaries on the types of learner strategies available to individuals. Cognitive styles are considered to be preferences in perceptual organizing and conceptual categorizing of the environment. A number of specific cognitive styles have been identified. While we will not attempt to go into the specific investigations of the relationship between cognitive style variables and performance, it should be noted that there is indication that cognitive styles are a variable to be considered in the development of adaptive instructional methods which match media or level of difficulty to the learner's style. The applicability of cognitive style characteristics to $COLT^2$ is presented with one example.

Learner Categories - Communication and Decision Processing. Cognitive style tests, named field dependence/field independence (Witkin, Lewis, Hertzman, Machover, Meissmer, and Wapner, 1954), measure the ability to isolate and process simple information from a more complex informational environment. The tests use geometric figures but seem to have correlation with a variety of real tasks. Kennedy (1972) found field dependence to be related to success in aviation training. The characteristic may have applicability to the communication training required for interaction between the artillery control console operator and fire direction officer in TACFIRE. Each has a separate domain of complex information available to him and each must be able to isolate information from it. The operator must isolate and pass information to the officer and the officer must make a decision based on that information and his own and then pass back an order to the operator.

Reception Preferences. Research has indicated that individuals have preferences for receiving information in certain ways (Hartnett, 1973). As with cognitive styles, these preferences can influence the strategies available to a student and the effectiveness of the application of an instructional strategy.

Learning Categories - Communication. Reception preference characteristics may be related to communication training. For example, Willeges (1966) found that when two channels of communication, verbal and visual, were used in a team, verbal communication training had no effect. Reception preference may be the reason for students using only the visual channel.

Motivation, Sex, and Prior Knowledge. It should also be noted that there are a number of other individual difference variables that could potentially influence the selection and utilization of particular learner strategies during $COLT^2$. Any comprehensive attempt to identify these variables and to take them into account for $COLT^2$ instructional strategies would have to include the motivation, sex and prior knowledge of the subjects involved in the instruction. Each of these variables has proven to be significantly related to learning outcomes.

LEARNER STRATEGIES

The three categories of learner strategies discussed in this section were first developed by DiVesta (1971) and were subsequently used by Dansereau et al. (1974). The categories are made up of comprehension, memory, and problem solving strategies. The remainder of this section will deal with each of these learner strategy categories--attempting to define the parameters of each category, providing a brief summarization of the state-of-the-art for learner strategies included within each category, and relating examples of specific learner strategies to the learning categories for team training. A series of tables corresponding to the learner strategy categories is included. Each table includes specific strategies, a summary of the research with implications for instruction, and a list of references. The purpose of the tables is to illustrate the current directions of learner strategy research. As might be expected, very little research has been conducted for the purpose of determining learner strategies used in team training.

Comprehension Strategies. Comprehension strategies relate to the acquisition of cognitive processes that occur during learning. Specifically, the strategies which have received the preponderance of attention from researchers are those which attempt to explain how the learner understands. As reviewed by Dansereau, considerable research has been conducted for the purpose of ascertaining the facilitative effects of comprehension strategies in the instructional process. The discussion on comprehension strategies includes coverage of the effects of organizational strategies (advanced organizers, passage organization, and post organizers), the effect of questions, notetaking, rule presentation, presentation of learning objectives, and reading flexibility. Table 4 presents a summary of organizational strategies.

Generally, the research dealing with comprehension strategies has progressed beyond the "basic" stage, and specific implications for educational applications can either be inferred or posited on the basis of empirical findings. Many of the comprehension factors which appear to have a substantial impact on student performance also have implications for development of educational materials. Furthermore, the dimensions of comprehension strategies for individuals appear to hold for team training.

Learning Category - Knowledge of Team Roles. Comprehension strategies are closely associated with team awareness. For example, a number of researchers have demonstrated that students tend to organize external stimuli in consistent, systematic patterns (Dansereau, et al., 1974; Cofer,

TABLE 4

LEARNER STRATEGIES: COMPREHENSION

Strategy	Comment	References
Advanced Organizers	Advanced Organizers are based on the premise that student's comprehension will be improved by instructing (training) them to strongly attend to materials which provide an overview of forthcoming materials (for example, outlines, previews, topic headings, etc.). A number of findings have served to support this premise. Most important, Ausubel (1960) confirmed that cognitive structure is hierarchically organized in terms of highly inclusive concepts under which are subsumed less inclusive subconcepts and informational data; thus providing guidelines for the development of advanced organizers within an instructional setting.	Ausubel, 1960. Ausubel & Fitzgerald, 1962. Ausubel & Youssef, 1966. Scandura & Wells, 1967. Merrill & Stolurow, 1966. Frase, 1969.
Passage Organization	There is substantial equivocality as to the effect of passage organization. However, there are a number of organizational factors which do appear to have a substantial impact on performance. A number of these factors also have implications for student strategies as well as for the development of educational materials. Effective passage orientation factors include the following:	Dansereau, et al., 1973. Cofer, et al., 1966.
	a) Material should be ordered from "easy" to "hard."	Boutwell, 1971 Moore & Goldidiamond, 1964.
	b) Related material should be presented contiguously.	Cofer, et al., 1966.
	c) Statements about all the attributes of the same concept should be grouped together as opposed to grouping statements about the same attribute for different concepts.	Schultz & DiVesta, 1972.
	d) Hierarchically related material should be presented from the top down (that is, highest level concepts first)...and in a breadth first manner (that is, all information at one level should be presented contiguously).	Newton & Hickey, 1965. Crothers, 1969
	e) Repetitions of material should not be grouped together but interspersed with other material.	Shaughnessy, et al., 1972.

(Table 4 continued)

Post Organizers and Reviews	Researchers have obtained results suggesting that advanced organizer type material (e.g. outlines, topic headings, reviews, etc.) may be more useful when presented after learning than before. With regard to summary-like reviews, there is support for the notion that reviews enhance comprehension and retention. Students should be trained to formulate their own reviews in the form of outline summaries, etc. in addition to attending very strongly to summaries actually presented within the instructional materials.	Bauman & Glass, 1969 Gay, 1971 Ausubel & Youssef, 1965.
The Effect of Questions	The research on this topic has been designed to determine whether first relatively specific questions presented in conjunction with the instructional material would facilitate criterion performance as compared to instruction without questions, and second, to determine the relative effects of placing the questions before the instructional material as compared with placing them after. The research findings indicate that whether questions are inserted before or after the relevant material, they nevertheless facilitate criterion performance. There is a difference in the effect of placement, however. Questions inserted prior to the passage tend to favor the acquisition of materials specifically relevant to the questions. Questions provided after the instructional passage have a more generally favorable effect provided that a sequence of such passages and subsequent questions is presented. An implication of the findings is that students should be trained to formulate their own questions following the presentation of instructional material.	Bruning, 1968 Rothkopf, 1966 Rothkopf & Bisbicos, 1967 Frase, 1968 Frase, 1970 Carver, 1972
Notetaking	Notetaking forces the learner to be active and provides the opportunity at least for the learner to reorganize and elaborate incoming information. The research on notetaking has been sketchy and inconclusive. A number of studies have found little or no effect due to notetaking activity. Other reports have found significant differences favoring notetakers on a multiple choice test.	Negative Findings: Pauk, 1963 Eisner & Rohde, 1959 McClendon, 1948 Positive Findings: McHenry, 1969 Peters & Harris, 1970 DiVesta & Gray, 1972 Fisher & Harris, 1973.

(Table 4 continued)

Rule Presentation	The most common type of learning undertaken by students is the acquisition of principles or rules. By learning rules in a specific situation as one of a class of situations, generalization of the rule-governed behavior is facilitated. The research indicates that the presentation of rule statements (1) reduces the number of examples required to meet criterion performance, (2) reduces total time required to meet criterion performance, (3) increases post-test performance, (4) increases retention performance, and (5) reduces state anxiety within the learning task.	Hansen, et al., 1973 Merrill, et al., 1972 Towle, 1973
Presentation of Learning Objectives	Considerable research has been conducted with the purpose to examine empirically the claims made for objectives in instruction. Hansen (1973) reports that in a review of 35 studies, about half failed to confirm the hypothesis that providing students with objectives leads to increased learning. The remaining studies showed facilitative effects.	Hansen, 1973 Merrill, et al., 1972 Merril & Duchastel, 1972
Reading Flexibility	Reading flexibility involves the ability to train students to vary their methods of reading according to the nature of the text and their purposes for reading it in order to improve the efficiency of their reading. However, a large number of studies aimed at assessing the degree to which students demonstrate this type of flexibility have produced equivocal results and have found surpisingly small changes in reading rates.	Herculane, 1961 Hill, 1964 Levin, 1968 Rankin, 1970

1966). In turn, the preorganization of instructional materials to correspond with those patterns has led to more efficient learning since the student is not as dependent on rational processes. In team awareness training, the organizational structuring of the materials in terms of content, sequencing, and display may be critical if the desired learning is to occur.

Memory Strategies. Atkinson and Shiffrin (1968) have argued for the importance of strategies in determining which information is entered into and retrieved from short and long term memory. These authors refer to processes that are not permanent features of memory, but rather transient phenomena under the control of the subject, as control processes. The appearance of these processes depends on such factors as the instructional set, the experimental task, and the past history of the subject. The purpose of this section is to discuss specific examples of these control processes as memory strategies, and if possible, to extend them into the instructional domain.

Memory strategies include the presentation of selection cues, mnemonic techniques, visual imagery, subjective organization, memory management, and retrieval strategies as shown in Table 5. Of the learner strategies listed, the first three appear to have direct and positive implications for instructional settings. Subjective organization, memory management, and retrieval strategies, on the other hand, have not proven, as yet, to constitute viable operational strategies for the development of instructional materials or for the specification of instructional strategies.

Learning Category - Communications. Selection cues and the use of mnemonic techniques have always been an integral part of Army artillery verbal communications. The TACFIRE system, which basically operates in a digital mode, in many cases eliminates the traditional verbal messages and replaces them with visual representations displayed on the TACFIRE CRT. Selection cues are reflected in the message format but no research has been conducted to establish the effectiveness of the present techniques.

Problem Solving Strategies. The third category includes learner strategies associated with problem-solving techniques. This category can be further broken down into learner strategies associated with problems which fall into two major types: closed-system problems and open-system problems. Bartlett (1958) described closed-system problems as ones that are formed in such a way that all the elements for solution are available and the problem solver has to fill in the appropriate element. In essence, closed-system problems are characterized by the existence of an identifiable solution and further progress toward this solution is usually also identifiable. Examples of closed-system problems would include anagrams, chess, logic, math problems, concept formation, equipment repair (trouble shooting), navigational problems, etc.

In open-system problems the problem solver must go beyond the units immediately given in order to discover a solution. Neither the solutions nor the progress towards solutions are readily identifiable. Examples of open-system problems include determing unusual uses for common objects, creating cartoon captions and movie titles, inventing a new device or product, writing a term paper, etc.

TABLE 5

LEARNER STRATEGIES: MEMORY

Strategy	Comment	References
Selection Cues	Selection cues are based on the notion that different portions of incoming information are selected for process based on functional cues which reflect task requirements. In effect, differential selectivity of information to be stored takes place depending on the task instructions.	Cermak, 1972 Jacoby, 1973 Butterfield, et al., 1971
Mnemonic Techniques	In general mnemonic strategies involve embellishing or elaborating the material to be learned into meaningful terms and then associating items to each other on a previous learned set of peg words or images. Some examples of mnemonic techniques include (a) visualization, (b) first letter, (c) peg word, (d) narrative chaining and (e) method of loci. A number of studies have shown that these techniques are dramatically more effective than rote rehearsal in learning serial list and paired associates.	Groniger, 1971 Nelson & Archer, 1972 Bower & Reitman, 1972 Santa, et al., 1973 Clark & Bower, 1969 Bower, 1973
Visual Imagery	Closely related to the use of mnemonic techniques is the training to apply visual imagery. The research on imagery and cerebral hemispheric specialization has presented substantial evidence for several hypotheses:	
	1) Encouraging subjects to create mental pictures of verbally presented materials greatly enhances retention of that material.	Bower, 1970 Paivio, 1969 Koser & Natkin, 1972
	2) Some types of materials are more amenable to imagery than others.	Paivio, 1969
	3) A relatively slow rate of presentation is generally necessary for the formation of images.	Weber & Castleman, 1970
	4) There are individual differences in the ability to form mental images.	DiVesta & Ross, 1971 Ernst & Paivo, 1971

(Table 5 continued)

	5) The ability to form visual images can be enhanced through training.	Brinkman, 1968
	6) Visual imagery involves a memory system that is separate from that involved in storing strictly verbal materials.	Paivio, 1971 Seamon & Gazzaniga, 1973
	7) Imagery and verbal memory systems serve to supplement each other.	Paivio, 1971
	8) Presenting visual information actually inhibits the formation of visual images.	Brooks, 1968
Subjective Organization	Subjective organization is closely related to encoding of information but has been treated by researchers in a somewhat separate fashion. In particular organization implies a grouping and relating of incoming materials. Stimulus materials can be grouped (classified and categorized) together on the basis of common properties and such classes can be related to one another in multiple ways. Training students to group together semantically similar material and to form these groups into organizational hierarchies when possible would constitute an effective means of promoting retention. In addition, in the development of instructional materials, semantic and hierarchical grouping should be a consideration and should form a basis for the development of the materials.	Wickelgren, 1964 Severin & Rigby, 1963 Earhard, 1967 Earhard & Endicott, 1969 Bower, 1970 Bower, et al., 1969 *Hansen, et al.*, 1974
Memory Management	Memory management involves the capacity of the student to decide what material should be stored in memory, when it should be stored, and how much effort should be applied to the storing process. In addition, a number of educationally relevant tasks are more efficiently accomplished if material is forgotten after it has become obsolete. Memory management relates to the ability of the student to both selectively store and forget materials. Research findings indicate that training in memory management for	Butterfield & Belmont, 1971 Aaronson, 1968 Gregg & Simon, 1967 Reitman, et al., 1973.

(Table 5 continued)

	individuals involved in tasks requiring high rates of information input appears to be effective. However, the overall results are too sparse to draw any specific implications for instructional environments.	
Retrieval Strategies	The research on retrieval has lead to more and definite results than memory management. However, studies demonstrating "tip of the tongue" behavior and "feeling of knowing" show that a stored item is frequently available at least temporarily not accessible. Retrieval strategies may be reflected again in the organization of materials and in query methods. However, as a viable operational strategy for development of computer assisted instruction retrieval strategies at this time are not well enough defined.	Brown & McNeil, 1966 Hart, 1965 Lindsay & Norman, 1972

In closed-system problem solving three distinct approaches have been investigated; (1) partist strategies, (2) wholist strategies, and (3) heuristics. Although only limited research has been conducted on each of these closed-system problem solving strategies, and research findings on the subject are not particularly substantial, there are implications for instructional processes associated with each strategy as seen in Table 6.

Learning Category - Problem Solving. For the most part, problem-solving strategies may be directly related to the team learner category of problem-solving. A good example is a "brainstorming" session. Members of a "brainstorming" group confront open-system problems on a team basis--each individual contributing ideas yet building on the contributions of the other members. A Delphi exercise is another example of team open-system problem-solving.

To illustrate team closed-system problem solving, an excellent example can be taken from Army artillery procedures. The most important problem faced by artillery personnel is how to accurately and effectively fire a round at an enemy. In order to resolve the problem, a number of individuals must coordinate information and actions.

COMPUTER-ASSISTED INSTRUCTION CAPABILITIES

CAI is, in part, an instructional delivery system and, therefore, a form of instructional media. CAI, as a media form, is a set of programmed components for presenting information, providing student interaction, monitoring student progress, and manipulating the sequence of instruction. Instructional strategies used in CAI differ from those with other methods of delivering instruction because they are a function of the media hardware and programming capability unique to CAI systems. The prime purpose of this chapter is to develop a conceptual framework for deriving instructional strategies relevant to COLT^2 with consideration of CAI capabilities. However, in order to do so it is necessary to describe the characteristics of CAI systems which are related to instructional strategies. These characteristics must be taken into account, along with the strawman framework developed for team task dimensions in Chapter 2 and the learner characteristics described in Chapter 3 to develop COLT^2 strategies.

CAI SYSTEM CAPABILITIES RELATED TO INSTRUCTIONAL STRATEGIES

Among the major factors in selecting a medium for delivery of instruction are the generic characteristics of the media which relate to the task to be learned. For example, generic characteristics might include motion, color, interaction, sounds and high fidelity representation of equipment. The selection or design of the CAI capabilities for team training and the choice of instructional strategies to be used are also related to the generic characteristics of the CAI system.

TABLE 6

LEARNER STRATEGIES: PROBLEM SOLVING

Strategy	Comment	References
Partist Strategies	In partist (scanning) strategies a portion of a positive instance is entertained as a hypothesis. Subsequent student effort is coneentrated on proving the hypothesis. The technique is applicable for both problem selection and reception paradigms. The disadvantage of partial strategy is that the subject need only to scan and remember the part of each instance that is relevant to his/her hypothesis. Therefore the subject concentrates only on part of what is seen and is not likely to learn much in the event a false hypothesis is being pursued.	Bruner, et al. 1956.
Wholist Strategies	In the wholist (focusing strategy) the subject selects a positive instance, retains all aspects of it, and attempts to determine which attributes are irrelevant by comparing his retained positive instance to other positive instances. The wholist strategy has been found to be more efficient in concept formation, but it is not frequently employed by subjects. Present research on the subject is not substantial enough to make positive inferences regarding instructional applications.	Bourne, 1963 Klausmeier & Meinke, 1968.
Heuristics	Heuristics are "rules of thumb" for decreasing the extent of an individual's search through an internal problem space. Two heuristics, means-ends analysis and planning have been incorporated into a computer simulated model of human behavior. The General Problem Solver (GPS), as it is called, appears to simulate quite accurately human behavior on problems in logic. It has also been expended to solve a variety of other closed system problems. However, the relationship of heuristics to the development of instructional material has not been documented.	Polya, 1957 Newell, et al., 1958. Ernst & Hewell, 1969.
Alterations in Consciousness	The research indicates that unconscious production and judgment of problem solution may be facilitated by alterations in consciousness (sleep, reverie, drug induced states, etc.) In fact, Green et al. (1973) have drawn a series of inferences to support the notion that alteration of consciousness by brain-wave training (biofeedback) may potentially enhance creativity. They note that many creative people report effec-	Ghiselin, 1952 Koestler, 1964 Green, et al., 1973 Schmeidler, 1965

(Table 6 continued)

	tive incubation and subsequent insight in states where visual imagery is enhanced (in addition, responses to a visual imagery questionnaire correlate .21 with responses to a creativity questionnaire, Schmeidler, 1965). Further, Green, *et al.*, have shown that subjects trained to produce theta brain waves report concomitant increases in visual imagery. They thus conclude that such brain wave training would enhance creativity via enhanced visual imagery, and have embarked on a research program to assess this hypothesis. Perhaps direct attempts at training imagery ability, as well as other imagery enhancement techniques such as meditation training, could be usefully employed in this regard.	
Creativity Facilitation	Certainly the greatest effort toward strategy training has been leveled at the creative process. Two studies are relevant to the training of students to prepare (problem translation primarily) for open-system problem solving. Hyman (1961) asked engineers to design a system for recognizing boxes in an automatic warehouse. Two attempts made previously had resulted in unsatisfactory solutions to the recognition problem. One group studied these previous attempts critically, in order to make up a list of faults; another group studied them constructively, in order to make a list of useful features. Later, when all subjects were asked to propose their own solutions to this problem, those who had studied constructively produced better solutions. A parallel study by Torrance (1964) reached similar conclusions. He asked psychology students to read two articles in psychological journals, either critically or imaginatively, before the middle of the term. Then they had to develop an original idea, theory, or hypothesis and turn it in on the last day of the term. Again, the products of those who had read imaginatively received superior ratings for originality. Although these studies have some obvious flaws, they do contain potentially suggestive implications for education, and probably deserve careful replication and extension.	Hyman, 1961 Torrance, 1964

(Table 6 continued)

Quantitative and Qualitative Problem Solution Production	A number of attempts have been made to improve the quantity and quality of solutions produced in response to an open-ended problem. Most courses in brainstorming (for example, Osborn, 1953) attempt to increase quality and quantity by instructing participants to postpone criticism. Generally, it is assumed that criticism and harsh evaluation will interfere with flexible idea production. Laboratory studies directed toward this issue have usually led to the conclusion that relaxed conditions and instructions not to evaluate produce more ideas and ideas that have a higher mean quality rating (as judged by "experts") than those produced under more restrictive and evaluative conditions. However, at least some researchers have concluded that instructions to "produce more ideas and withhold judgement" lead to a greater number of ideas, but an overall mean decrease in quality. It is probably the case that these different results are due to differences between the subject populations.	Osborn, 1953 Johnson, et al., 1968 Meadow, et.al., 1959 Dentler and Mackler, 1964 Gerlach, et al., 1964.
Morphological Synthesis	Researchers attempting to evaluate the effect associated with the training of specific idea-producing techniques have focused on Allen's (1962) morphological synthesis approach. This technique requires analysis of the dimensions of the problem followed by a new synthesis. Ideas for improving one feature of the product are listed along one axis of a two-dimensional diagram and ideas for another feature are listed on another axis so that novel combinations appear at the intersections. In comparison to two other idea-generating techniques, Warren and Davis (1969) found increased productivity and more superior solutions with the morphological synthesis technique. Furthermore, this technique has been included in a large-scale training program for adolescents with apparently favorable results (Davis, Houtman, Warren, and Roweton, 1969).	Allen, 1962 Warren & Davis 1969 Davis, et al., 1969.

Prime components of media hardware for CAI are the presentation devices for visual information. Several different types of visual information may be presented depending on the system. In some systems only alphanumeric text can be presented, and in others, it is possible to represent pictorials with graphics. The type and complexity of graphics may also vary. For example, still graphics such as diagrams, graphics which have partial movement only, or full-dynamic graphics similar to animation may each be possible depending on the system. Some systems also have the capability to present slide or microfiche pictures. Other systems are capable of presenting motion pictures through computer-controlled videotape, as exemplified by TICCIT developed by the MITRE Corporation of the Navy's Computer Controlled Multi-Media System $(CM)^2S$. The use of split screens or more than one visual presentation monitor is also possible, such as the Computer-Based Training System developed by General Electric Ordnance Systems or the $(CM)^2S$ system. As an example of how the presentation media relates to $COLT^2$ strategies, one review of team training (Wagner, Hibbits, Rosenblatt, and Schulz, 1976) suggested the possibility of using split screens to present information relevant to the position being trained, as well as information showing the trainee the status of the coordinating position.

Response devices, as part of the media hardware, also influence which instructional strategies are possible. Typical response devices include standard keyboards, special function keyboards, graphic writing tablets. lightpens, touch panels, voice recognition systems, trackballs and special adjunct console controls. The choice of response device determines the mode of input during the interaction of student and system. The interactions are a result of the instructional strategies that are defined and the particular input device used influences the strategy.

Because of the nature of the presentation and response devices in a general-purpose CAI system, questions of fidelity and transfer of learning for many tasks involving equipment operator training may arise. This may be true in a learning task involving a man-machine system such as TACFIRE, which is of special concern in this study, although it is anticipated that the actual TACFIRE system will be used in a CAI mode during later stages of the study. It should be recognized that CAI instructional strategies, such as student-progress diagnosis in real-time, pacing, adaptive instruction, feedback, and optimization, can be used with many operational man-machine systems with greater fidelity than that available on general CAI systems. Therefore, this study will take into account both general CAI systems and operational man-machine systems with CAI in regard to instructional strategies.

Similarly, the computer software available influences instructional strategies. Just as the current team-training version of PLANIT can assist in developing some $COLT^2$ instructional strategies, we may expect additional software capabilities to provide for other strategies. Software capabilities required can also be related to computational capabilities, such as those used in optimization or adaptive techniques, and control of media presentation hardware and response devices.

CAI MODES

Table 7 presents the names of instructional strategies found in the literature on CAI. It should be noted that several of these names are repeated in the various categorizations of instructional strategies. For example, drill, or drill and practice and a tutorial type of CAI are represented in some way in most of the lists. Only Hickey's (1968) definitions are shown since he has summarized most of the others.

However, while these names are termed instructional strategies, as in the case of Hickey, they are probably more properly called modes of CAI in that they represent purposes for which CAI may be used in the overall instructional design. For example, drill and practice may be used, as described by Suppes (1969), to supplement the regular curriculum taught by a teacher. The introduction of concepts and new instruction is handled in a conventional fashion by the teacher, but the computer takes the role of providing review and practice on those concepts and new instruction. While drill and practice represents an instructional strategy, in part, there are many more details to consider. For example, in the Stanford program on mathematics (Suppes, Jerman, and Brians, 1966), an algorithm was developed for determining mastery of materials and for adapting the drill to a learner's state. Algorithms of this sort can vary and, as they vary, they represent differences in the instructional strategies. In fact, it is one of the benefits of CAI that such algorithms can be performed in real-time with dynamic decision making about the student's learning state and the information to be presented. The point is that the instructional strategies represented in Table 7 are actually overall purposes which are probably better termed modes. Instructional strategies, per se, are more appropriately considered to be combinations of the CAI modes, the media characteristics, the algorithms used as a function of the software available, the components of the instructional setting which are adjunct to the computing system, and other factors.

CAI STRATEGIES

While the modes of CAI described above denote the general characterization of instructional strategies in a computer-based system, they do not specifically delineate the techniques used to achieve the goals (direct instruction, drill, etc.). It is the purpose of this section to develop a framework of the considerations involved in designing the details of instructional strategies with a CAI system. The decisions in specifying CAI instructional strategies are many and include content, amount and type of student control, media selection for presentation and interaction, difficulty levels, adjunct materials, and pacing.

In this report COLT^2 instructional strategies have been defined by three major components. These are:

(1) Team task dimensions and team training objectives;

TABLE 7

REPRESENTATIVE CAI MODES DEFINED IN LITERATURE

Hickey (1968)
- (1) Tutorial
  - (a) Linear: straight line, non individualized instruction
  - (b) Intrinsic: individualized, branching instruction
  - (c) Adaptive: instruction which uses decision making models to make successive decisions from instructional alternatives to adapt the instruction to the learner
- (2) Socratic: Tutorial but allowing student to assert an answer or solution and ask for information. Similar to Suppes Dialogue mode.
- (3) Learner Controlled: Instruction allowing student to select path of events.
- (4) Simulation: Instruction which duplicates in the learning situation the format and sequence of stimulus events in the real world.
- (5) Game: A form of simulation involving situations of competition or conflict.
- (6) Testing: Testing is viewed as an instructional strategy by Hickey because, with CAI, techniques may be used encompassing branching, math models, decision theory, and other decision making procedures of CAI. The testing may also be embedded in the CAI as an integral part.

Suppes (1969)
- (1) Drill-and-Practice
- (2) Tutorial
- (3) Dialogue

Stolurow (1969)
- (1) Problem solving
- (2) Drill-and-Practice
- (3) Inquiry
- (4) Simulation and gaming
- (5) Tutorial instruction

Zinn (1967)
- (1) Drill
- (2) Author controlled tutorial
- (3) Dialogue tutorial
- (4) Simulation and gaming
- (5) Retrieval and reorganization of information
- (6) Problem solving
- (7) Artistic design
- (8) Composition

Rodgers (1967)
- (1) Drill
- (2) Tutorial
- (3) Conversational
- (4) Simulated environment
- (5) Simulated decision

(2) Learner characteristics and strategies;

(3) Characteristics of the delivery system which are used to both restrict and implement strategies.

Team task dimensions and learner characteristics and strategies were discussed in previous chapters. CAI delivery system characteristics, as presentation and response media that are used with programming to implement instructional strategies, were described earlier in this chapter. A good framework for deriving COLT^2 instructional strategies must take into account these components of instructional strategies.

To develop a strawman framework, the following strategy variables commonly found in CAI strategies for individualized instruction were used:

(1) Presentation/stimulus variables

(2) Sequence variables

(3) Response mode variables.

(4) Measurement variables.

Because of the nature of CAI as an interactive, programmed, multi-mediated delivery system for instruction, the categories overlap and are interdependent. However, they serve the purpose of providing a checklist and categorization of the necessary considerations for defining CAI instructional strategies. Taken with CAI modes, team task dimensions, and learner characteristics and strategies they will provide a basis for COLT^2 strategies.

That aspect of the instructional strategy which is designed to manipulate the presentation/stimulus variables is perhaps one of the most visible aspects of an instructional strategy directly associated with the hardware system characteristics. The presentation/stimulus variables include the information to be presented, the form of the information such as audio, textual, or pictorial, the format of the information, the amount of information, and the time the information is presented. These display variables are obviously a function of the system capabilities for presentation of information. In a situation where the actual, operational computer system is used, the limitations of the equipment displays will produce a high fidelity training situation if they are used in a CAI mode as in actual operation. If the displays cannot be used, transfer of training may be a question. Regardless, the instructional strategies will be limited to the display capabilities available. Five generic CAI presentation/stimulus variables may be defined. These are:

(1) Content

(2) Media (such as textual, audio, pictorial, and graphics)

(3) Format (such as information mapping and text clustering)

(4) Prompting

(5) Feedback (including knowledge of results, reinforcement, confirmation, and delay of feedback).

The literature on these variables in individualized instruction is voluminous and no general, up-to-date reviews are known. However, the literature will be studied for relevancy to $COLT^2$.

The sequencing of the presentation/stimulus variables may be accomplished in a variety of ways with CAI. Hickey (1968) has reviewed some of the common sequencing techniques used for individualized CAI instruction. These are:

(1) Linear

(2) Branching

(3) Adaptive

(4) Optimization

(5) Forward or backward chaining

(6) By content structure, such as with concept learning (Markle and Tiemann, 1969).

In addition, tests and reviews may be sequenced by any of the above techniques or be embedded in part-versus-whole or in the-beginning-versus-the-end of instruction.

The response mode in CAI interaction must also be specified by an instructional strategy. Response-mode issues usually center around the selection of multiple-choice or constructed-response questions or some combination of these modes (Tobias, 1972a, 1972b). In addition, the response media may differ. A variety of response media are available, such as keyboard, the mouse, the lightpen, and the touch panel. The situation where the actual operational computer system is used in a CAI mode is of special interest in specifying the response mode for $COLT^2$. In this case higher fidelity of the response mode may be attainable at some additional cost but with an effect of positive transfer of training.

The measurement techniques used in CAI are also part of the instructional strategies since many of the presentation variables, response modes, and sequencing techniques, as well as student evaluation, depend heavily on the measuring techniques used (Hansen and Johnson, 1971). In adaptive instruction, for example, preliminary measures such as scores on personality scales, achievement scales, and aptitude scales may be used in regression models (Rivers, 1972; Suppes, Fletcher, and Zanotti, 1973a, 1973b). These student characteristics, including measures of learner strategies, are also the basis for many of the decisions in CAI instructional strategies, both pre-instruction and within instruction. Besides these measures, within instruction measures are usually in two forms: (1) the criterion examination, and (2) response latencies. Another type of measure sometimes used is error rate. Several items of importance for measurement strategies in COLT^2 may be noted at this point. First, as pointed out by Faust (1976), very little has been done in measuring team learning progress within instruction. Usually only a final criterion measure is used to measure team effectiveness. Along these lines also, little has been done to measure specific team task dimensions other than communications variables. Secondly, measures of team performance do not usually have well-defined conditions for the role and specific behavior of each individual in relation to the team goal.

COLT^2 STRATEGIES

COLT^2 strategies are considered to be the results of considering team task dimensions, learner characteristics and strategies, and CAI capabilities. The CAI capabilities consist of system features, modes, and CAI strategies or techniques. In particular, this section focuses on the relationship between CAI capabilities and COLT^2 instructional strategies.

CAI System Capabilities. In this study, the target team system for implementation and brassboard testing is the Army's TACFIRE system. It is planned that eventually the TACFIRE operational system will be used in a CAI mode for team training. Therefore, while the study encompasses general CAI system features available for team training, emphasis will be placed on the use of the TACFIRE system with its particular display, response, and programming capabilities. The TACFIRE artillery control console displays are alphanumeric oriented and limited to a relatively small amount of information. No graphics or picture media are available. Response capability is limited to a keyboard.

In many regards, implementation of COLT^2 on TACFIRE will be a first. While several computer-based operational systems are used for team training none is known which operates in a COLT^2 mode. The Navy's TACDEW system is probably the closest; as a team trainer, some CAI capabilities are used. A Navy system, the Multi-Environment Trainer (MET), yet to be built for the Royal Saudi Navy, may more significantly approach a COLT^2 system. The contract for the MET has not been awarded as yet; however, preliminary information indicates that the MET will be required to have CAI features, using operational equipment, for individual, subteam, and team training in combat information centers, sonar, bridge, and other ship areas.

CAI Modes. It is of interest to associate some of the team training literature with the standard definitions of CAI modes. First, while there is some conflicting evidence, it appears that individual training to proficiency should come before team training (Hall and Rizzo, 1975; Wagner, Hibbits, Rosenblatt, and Schulz, 1976). It is possible, therefore, that before beginning actual team training either individual tutorial or drill CAI modes should be used with CAI testing modes to ensure that individuals are ready for team efforts. Another example of CAI modes in a COLT^2 application is the Navy TACDEW system which is used primarily for maintenance and upgrading of team skills. Thus, COLT^2 would be used in a drill-and-practice mode for TACDEW teams.

The CAI simulation mode is important in terms of fidelity both in the sense of the TACFIRE application in this study (the actual operational system in a CAI mode) and the question of amount of fidelity required. The capability to emulate TACFIRE operations, on the TACFIRE equipment while in a CAI mode, has been developed (Germas, 1976). The question of how important is it to make the TACFIRE system displays operate exactly as they normally would was discussed by Wagner, et al. (1976) as being a major research area required for team training.

Finally, with regard to CAI modes, it is noted that Wagner, et al. (1976) proposed that two-sided engagement simulation techniques may be of special help in acquiring team skills. This technique corresponds to a special case of simulation called games. CAI may have capabilities of a useful nature for two-sided engagements, such as dynamically changing game values of either the adversary or home team based on real-time interactions.

<u>CAI Strategies.</u> The topic of how CAI strategies can be used in $COLT^2$ will be a continuing subject of the study. However a few examples of what the literature on team training suggests are in order.

Feedback in team training was of special concern both in the Hall and Rizzo report and in Wagner, et al. (1976). This includes questions concerning knowledge of results, immediacy or delay of feedback, and extrinsic or intrinsic feedback. Hall and Rizzo make reference to feedback in regard to stereotypic or perseveratory behavior during decisionmaking. Within the conceptual framework of the present study these student characteristics would be viewed as possible undesirable learner strategies which might be modified with appropriate feedback during instruction. This example illustrates the use of feedback during $COLT^2$ to restrict a learner strategy or characteristic to teach awareness of the team goals and roles (team task dimensions). It will be the emphasis in Task 2 of this study to continue listing such examples and testing their use against team training scenarios.

CONCLUSIONS

Two major conclusions concerning team training resulted from the state-of-the-art assessment of instructional strategies. The first conclusion is that a conceptual framework for a general purpose set of instructional strategies for team training does not exist. The framework must be derived analytically and tested empirically. The framework must also define instructional strategies so that they are responsive to elements which are developed during the ISD process. Specifically, this report addresses the concept of instructional strategies for $COLT^2$ by three such elements: team task dimensions, learner characteristics and strategies, and computer-assisted instruction system capabilities. The definition is the starting point for Task 2 and will act as a strawman framework for the procedures used in deriving team training strategies.

While many of the ISD components for team training will be the same as individual training, with the exception of additional team task dimensions, this is not necessarily true for instructional strategies. Instructional strategies in this team task must take into account analysis of the task information, such as cooperative actions, in deriving appropriate instructional actions. Strategies used to train familiarization with procedures will probably be insufficient. It is the dimensions of the task that drive the requirements for these new strategies. For example, considerations in individual training design include real-time or delay of feedback, the amount of information given in feedback, and whether feedback is intrinsic or extrinsic to the task. These same considerations for feedback strategies may be utilized in team training, but within a different situational context, such as that of communication and coordination for tactical decisionmaking. These are the task dimensions.

The phrase instructional strategies was first described by Stolurow (1961) in terms of the logical flow of the instruction in considering the branching structures for correcting error resoponse or applying remediation. The concept of instructional strategies thus has been with us for more than fifteen years. More recently it has been integrated into the systems approach to curriculum design and development. However, as pointed out by Gropper (1974), the literature on instructional design has grown rapidly over the last several years, and the formulation of instructional strategies has had unsystematic descriptions in most ISD models. Definitions of what is meant by instructional strategies are, therefore, not usually comprehensive or operational. Gropper uses the term instructional strategies to refer to prescriptive rules for designing instructional events which create learning experiences appropriate for the mastery of behavioral objectives. According to this definition, the emphasis must be placed on the properties of behavior which the instructional events must be responsive to and then on the properties of the instructional events which make them responsive.

The documentation for interservice ISD procedures does not specifically use the phrase instructional strategies. However, the ISD components which are defined do contain the same elements of instructional strategies as defined by Gropper. After job/task analysis, selection of instructional setting, definition of objectives, and test development, the instructional sequence and structure is determined with specified learning events and activities. Thus, as with Gropper's definition, the strategies for meeting the required objectives consist of the activities of sequencing, structuring, and specifying learning events/activities. More specifically, these activities, as defined by Hansen (1973), are a series of decision points which provide for structuring the instruction with variables such as media choice, content, pacing, level of difficulty, reading level, or feedback.

In developing the conceptual framework for deriving team-training instructional strategies, it was concluded that these decision points are based upon three types of information: the characteristics of (1) the task to be learned; (2) the learner; and (3) the delivery system for instruction. In other words, team-training instructional strategies are derived on the basis of task dimensions, learner characteristics/strategies, and CAI capabilities.

The second conclusion is that an Instructional System Development (ISD) approach must be developed for team training. Instructional strategies for team training cannot be developed or empirically tested without taking into account the problems of task analysis, development of learning objectives, selection of a delivery system, and other ISD procedures. This report has produced a first pass at providing the framework for an ISD approach to team training. The details of this framework will be refined during the remaining tasks in the study. The framework will serve as a strawman which will permit the discernment or invention of instructional strategies appropriate to the training setting.

As pointed out by three recent reports on team training (Hall and Rizzo, 1975; Faust, 1976; Wagner, et al., 1976), most of the research conducted on team training has dealt with isolated portions of ISD procedures. The conclusion drawn from these sources and also from the present Task 1 effort is that a total systems approach to design, development, and evaluation of team training is required. Furthermore, the final objective of this study, a coordinated lesson scenario, must, in essence, be a systems approach for team training ISD.

A major premise of this report is that the path to developing a systematic approach to team training ISD is through team task analysis. It is believed that team-task dimensions will also delineate other major components of a team training ISD approach. For example, just as training objectives are derived from task analysis in individual instruction so must they be for team training. The same elements for an individual training objective must be present in a team training objective: observable outcomes must be defined, task conditions must be specified, and performance criteria must be set. It is of prime importance that while the elements of a team training objective are the same as an individual training objective, additional team-task dimensions are needed on each of the three elements.

A similar case can be made for proficiency measures of team training. For example, it is probable that the generic measures of accuracy and speed apply to team training just as they do to individual training. It is only when the team-task dimensions are added that the measures become meaningful for team evaluation. This is an implied principle, for example, in TACDEW system training where the performance variables are measured by accuracy and time, and dimensioned by the situational variables of the task environment (Chesler, 1971).

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